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ABSTRACT

Interest in mathemagenics (adjunct aids used in text to enhance learning) has most likely resulted from the indirect effects of inserted postquestions, whereby the learning of unquestioned material is enhanced as well as that of questioned material. However, since most mathemagenics research has occurred in laboratory settings in which subjects were prevented from turning back to a text segment once they had encountered a postquestion, the effects of mathemagenics in naturalistic settings remain problematic. A study was conducted to examine the nature of the nonreview constraints and to compare the results to those obtained in a naturalistic setting in which review was allowed. Subjects were 99 secondary school students who were placed in either an experimental (review) or a control group (nonreview) and given a 1,700 word passage to read. Those passages used by the control groups did not contain inserted questions; however these subjects were told that they would be asked to recall as much as possible about the passage after reading. All subjects were given free recall and cued recall tests following the experiment. Results showed that, contrary to expectations, relevant learning was not enhanced by inserted questions in the text. In addition, incidental learning was also slightly depressed by the use of inserted questions. This was true for both review and nonreview groups. (Materials used in the study are appended.) (FL)

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# MATHEMAGENICS AND REVIEW CONSTRAINTS

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Acknowledgements: I would like to thank Miss Pat Crowsley for her assistance in conducting this research. I would also like to thank Mr. Moon, and Mr. Green and his colleagues for their co-operation and assistance in arranging for the study at the Bridgewater Hall School in Stantonbury and in helping with the sessions.

## MATHEMAGENICS AND REVIEW CONSTRAINTS

The term 'mathemagenics' covers the full range of adjunct aids which can be employed in textual situations to enhance learning, although it is known primarily for the use of adjunct questions inserted in text. Mathemagenics is a well established area of educational research, with already an extensive literature and a good number of reviews (cf. Duchastel, 1978) to consolidate its findings.

Most of the interest in mathemagenics has most likely resulted from the indirect effects of inserted postquestions, whereby the learning of unquestioned material is enhanced as well as that of questioned material, although to a lesser extent. In other words, all textual material can be better learned even though the inserted questions themselves can only cover certain parts of the material (cf. Rothkopf, 1976, for a recent review). While this conclusion may have some trouble generalising from low levels to high levels of learning (Rickards, 1977) and while the effect may be slightly confounded by time (Faw and Waller, 1976) although probably very slightly if at all, the effect does appear persistent and is generally acknowledged.

What remains problematic, however, is the external validity of the effect. Put directly, the question is to what extent the effect will hold up in naturalistic settings. Practical advice to instructional designers which is based on the literature of inserted questions must be tempered with caution (Duchastel 1978).

The reason for this state of affairs is the lack of congruence between the experimental paradigm underlying most of the literature and learning strategies adopted in naturalistic settings. Indeed most experiments in which inserted postquestions were examined prevented the students from turning back to a previous text segment once a postquestion was encountered.

This is understandable, since if the students were allowed to look back, questions might well, in fact, become pre-review questions, if not outright pre-questions.

The unnaturalness of this is unsettling, for few practical settings embody the sequential study constraint imposed in the experiments. Thus, while the indirect effect of inserted postquestions may be very real, it remains plausible that we are dealing with an effect created in the laboratory, with only the most tenuous connection to the outside world. The issue is thus, one of some importance.

Three previous studies known to me have relaxed the non-review constraint. One of them was the very first study in the area, by Washburne (1929) who found that inserted postquestions generally increased questioned learning only at the expense of unquestioned learning. The second study, by Gustafson and Foole (1970), found postquestions to enhance questioned learning and not to affect unquestioned learning either way (no enhancement nor any suppression). The third study, by Hiller (1974), examined only the effects of postquestions on unquestioned learning and found that at times they depressed this type of learning. This effect, however, interacted with question difficulty and disappeared on a retention test two weeks later.

In sum, the three studies which relaxed the usual non-review constraint failed to follow the rest of the research literature in reporting enhanced unquestioned learning and at times found effects opposite to the usual ones (suppression of this learning) along the lines of a selective learning model. The purpose of the present study is to directly examine the nature of these effects by comparing a review condition to a non-review one and by examining the direction and generality of the effects (cf. Rickards, 1978).

## METHOD

### Materials

The learning passage employed in the study was developed by the author. The 1700-word passage entitled 'The Victorian Era', contained 12 topical paragraphs, each dealing with a separate topic involved in the period of British history covered by the reign of Queen Victoria (1837-1901). The text also contained an introduction and a conclusion which were simply meant to frame the context of the passage; however only recall of the 12 topical paragraphs was examined later in the students' protocols. A typical paragraph follows:

"A few years later took place the Great Exhibition of 1851. It was an idea thought up by Prince Albert and it brought together under one roof numerous displays of industrial achievement from Britain and other countries. These were all housed in a very large glass hall called Crystal Palace which was built in Hyde Park. Many years later unfortunately, the Palace burnt to the ground. It was a grand sight in its day, however. Some days the entry fee was five shillings and it is then that the aristocrats and the rich went to visit it. On other days, the fee was only one shilling and the crowds poured in from every part of the country. Many of the exhibits were later preserved in a new museum which was called the Victoria and Albert Museum."

The 12 topics presented in the passage were the following, in their order of appearance: Prince Albert; the Corn Laws; the Great Exhibition, the Crimean War; the changing role of women; India; Livingstone; the Suez Canal; Irish Home Rule; the Queen's Jubilees; Trade-Unionism; the Boer Wars.

The passage is largely based on the account of the period given in Burke's An Illustrated History of England (1974). The passage was written in such a way that it could be easily understood by the 15 year-old students taking part in the study.

Design and subjects

The experiment involved a 2 x 2 design (Questions x Review) with 23 to 26 subjects per cell. Six of the twelve topical paragraphs in the passage were each followed by two inserted post-questions while the other six were not. Thus, repeated measures analyses comparing question sets were also made possible. Questioned and unquestioned paragraphs were sequenced in a mixed order so that the students would not guess after a while which of the paragraphs would be questioned(as might be the case if only alternate paragraphs were questioned). The inserted questions were placed at the top of the page which followed their relevant paragraph.

Directions to half of the students indicated to them that once they had turned a page of the passage, they were not allowed to turn back and look at it again. The other half of the students were told (in their directions) that they were allowed to turn back to the previous page if they wanted to before going on. This is what constituted the Review manipulation in this study.

The experiment also involved two control groups which studied a version of the text which contained no inserted questions. These groups were included in order to establish appropriate recall baselines. One of the control groups was allowed immediate review (review of the previous page), while the other was not. It should be noted that in neither of the experimental or control conditions were the students allowed to review the whole text after it had been read once.

The subjects were 99 secondary school students in a British comprehensive school. They were, on the whole, 14 or 15 years old. The number of subjects in the experimental and control groups were approximately equal.

Posttests

Two tests were developed for the passage, in order to reveal different aspects of learning. These were as follows, in order of presentation:

- Topical free recall: the students were asked to recall the 12 major events presented in the passage and to list them in a few words each.
- Cued free recall: this consisted of 36 explicit questions requiring the student to provide an idea or a detail from the passage. The following is a sample question: "Who first thought of the Great Exhibition?" This test was made up as follows: (i) the 12 items seen previously in the inserted question condition; (ii) 12 new items related to the 6 questioned paragraphs; and (iii) 12 items unrelated to the questioned paragraphs (and hence related to the unquestioned paragraphs). The items were not set out in blocks of 12 on the test, but rather followed the order of occurrence of events in the passage.

Procedure

The study was conducted with two groups of students during regular class time. In each group the students were randomly assigned to the four cells in the design by random allocation of the materials, which were contained in brown manilla envelopes. Written instructions introduced the students to the task and indicated to them that they would later be asked to write down the main points that they could remember, and that they would be asked specific questions of detail as well.

The instructions for the students in the inserted questions condition indicated to them that trying to answer the questions they encountered

in the text would help them find out whether they could remember the ideas in the text as they read it. The instructions concerning the review/non-review conditions were explained above in the Design section.

Time was also a factor in this study. The students, when finishing reading the text, wrote down in a box provided at the end of the text the number which appeared on a chart at the front of the hall where the experiment took place. This figure was the number of elapsed minutes since the start of the study phase and it was updated every minute by the experimenter.

The students were given a maximum of 15 minutes in which to read the text, after which time they proceeded to the posttests. The students had ample time to respond to each of these tests.

The tests were corrected in a blind manner, whereby the person correcting the tests (a research assistant) was not aware of the group identity of the pupils as she examined their answers.

## RESULTS AND DISCUSSIONS

The mean scores obtained on the various subtests used as well as the mean time of study are presented by group in Table 1. The non-review condition groups (right-hand side of the Table) represent the classical experimental groups utilized in mathemagenic research. Unfortunately, the results obtained under this condition in the present study fail to replicate the usual results obtained in the literature on inserted questions. Thus, contrary to expectation, relevant learning (scores for questioned topics and repeated questions) was not enhanced by the fact that the students encountered inserted questions in the text. Also contrary to expectation, incidental learning was slightly depressed rather than enhanced by the provision of inserted questions. Incidental learning corresponds here to the scores for unquestioned topics and for unrelated questions.

TABLE 1

Means of the Test Subscores and Mean Time for Each of the Four Groups.

| | Review Condition | | Non-Review Condition | |
|---|---|---|---|---|
| | Inserted Questions | No Questions | Inserted Questions | No Questions |
| | N = 26 | N = 25 | N = 25 | N = 23 |
| Topical test | | | | |
| Questioned topics | 4.7 | 4.2 | 4.1 | 3.9 |
| Unquestioned topics | 2.7 | 3.6 | 2.9 | 3.6 |
| Total | 7.3 | 7.8 | 7.0 | 7.5 |
| Cued-recall test | | | | |
| Repeated questions | 8.3 | 8.1 | 7.4 | 7.4 |
| Related questions | 7.9 | 7.5 | 7.2 | 7.1 |
| Unrelated questions | 5.2 | 5.1 | 4.7 | 5.6 |
| Total | 21.5 | 20.7 | 19.2 | 20.1 |
| Time | 12.9 | 12.8 | 13.6 | 12.6 |

The condition groups in which review was permitted (left-hand side of the Table) display results which parallel those just presented : relevant learning is not substantially enhanced, and incidental learning is either unaffected by the inserted questions (on the cued recall test) or slightly depressed (on the topical test) as in the non-review condition.

Time means are generally consistent across groups with the highest time mean occurring in the non-review/inserted questions group.

The intention of this study was to examine how the review constraints usually imposed in this type of research compare in terms of results with a variation of the constraints which more closely approximates to real study

settings. However, because the non-review condition in this study failed to replicate the usual pattern of results encountered traditionally, little can be said concerning variations from this condition. To be able to do that, one would have to have first replicated the traditional results in the non-review condition. Further analyses based on the present set of data would be misleading.

Consideration of the procedures involved in the study or of the materials employed give little indication of the underlying reasons for which the usual results have not been obtained. The students did seem to take the task seriously and, as far as can be gauged, to have followed the directions provided to them. The strategies which were involved in the treatments were under their control, but the main variable of concern here, namely the provision or not of inserted questions, was not.

The scoring of the protocols did present problems in that the answers to some of the questions were at times difficult to evaluate because of the particular way the answers were put. This is a hazard common to most free recall scoring situations and it may account to some degree for the results obtained. It is possible in other words that the reliability or validity of the scoring procedures may have been wanting.

In conclusion, the main hypotheses developed for this study were unable to be verified because the condition in the study which was to serve as a baseline of sorts for the comparisons failed to replicate in terms of results the traditional findings in the field. It is felt that the problem suggested in this paper is still one which needs to be examined, only in a way which will first provide the expected replication of the classical paradigm.

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APPENDIX

EDUCATIONAL RESEARCH STUDY-II

DIRECTIONS

You are taking part in an educational research study which is investigating how much people remember what they read and study.

Your task is to learn as much as you can (both main ideas and details) from reading a brief history text (in the envelope). You will only be allowed to read the text once. After that, there will be a test. It will ask you to write down the main ideas and will also ask you to answer specific questions of detail.

At various points in the text, there will be questions on what you have just read. You should try answering these questions in your head - do not write answers to them. Trying to answer these questions will help you find out whether you can remember the ideas in the text you are reading.

Important: once you come upon one of these questions in the text, you may if you want look back to the previous page but try nevertheless to answer the question beforehand.

Study the text carefully and do not skip ahead. Take as much time as you need for each page. You will not be allowed to revise at the end. Also, do not take any notes and make no marks on the text itself.

Not all pupils in the class will be studying the text in the same way, so do not worry if they do something else. Just follow the directions given on this sheet.

When you finish, write down the number which appears on the chart at the front of the room. There will be a space at the end of the text to do this. Then turn the text face down on your desk and wait for the test in silence so that the others can finish.

Right now, please write your name here: .....

Also indicate whether you are ☐ male; or ☐ female and write your teacher's name here: .....

Your teacher will tell you when to take the text out and start reading it.



/ER

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Important: You should read the text page by page; however after turning a page, you may if you want look back to the previous page to revise before going on. However, you are only allowed to turn back to the previous page and not further back than that.

Study the text carefully and do not skip ahead. Take as much time as you need for each page. You will not be allowed to revise at the end. Also, do not take any notes and make no marks on the text itself.

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